Biological Data on Pacific Herring (*Clupea harengus pallasi*) from Tuktoyaktuk Harbour and the Liverpool Bay Area, Northwest Territories, 1981 to 1983

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BIOLOGICAL DATA ON PACIFIC HERRING (*Clupea harengus pallasi*) FROM TUKTOYAKTUK HARBOUR AND THE LIVERPOOL BAY AREA, NORTHWEST TERRITORIES, 1981 to 1983

by

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ABSTRACT

Gillman, D. V., and A. H. Kristofferson. 1984. Biological data on Pacific herring (Clupea harengus pallasi) from Tuktoyaktuk Harbour and the Liverpool Bay area, Northwest Territories, 1981 to 1983. Can. Data Rep. Fish. Aquat. Sci. 485: iv + 22 p.

This study represents the initial step to determine the feasibility of establishing a commercial fishery for herring roe in the Tuktoyaktuk area, Northwest Territories. Pacific herring were captured with experimental gillnets in Tuktoyaktuk Harbour in May and June, 1981, and in June, 1982. Similarly herring were taken in the Liverpool Bay area in June, 1981, June and July, 1982, and June and September, 1983. Spawning apparently began when surface water temperature reached 2.5 to 3.5°C. Hazardous ice conditions in Tuktoyaktuk Harbour just prior to spawning suggest that this area is unsuitable for a roe harvest operation. More favourable conditions appear to prevail in the Fingers area of Liverpool Bay. Biological data (length, age, weight, sex, maturity, condition) from samples of herring taken during this study are presented in this report.

Key words: age composition; catch/effort; experimental fishing; gillnets; sexual maturity; size distribution; spawning seasons.

RESUME

Gillman, D. V., and A. H. Kristofferson. 1984. Biological data on Pacific herring (Clupea harengus pallasi) from Tuktoyaktuk Harbour and the Liverpool Bay area, Northwest Territories, 1981 to 1983. Can. Data Rep. Fish. Aquat. Sci. 485: iv + 22 p.

Cette étude constitue la première étape pour déterminer la faisabilité d'une pêcherie commerciale d'oeufs de hareng dans la région de Tuktoyaktuk (Territoires du Nord-Ouest). En mai et juin 1981 ainsi qu'en juin 1982, des harengs du Pacifique furent pêchés dans le port de Tuktoyaktuk à l'aide de filets maillants expérimentaux. Parallèlement, des harengs furent pêchés dans la baie de Liverpool en juin 1981, en juin et juillet 1982 ainsi qu'en juin et septembre 1983. Apparemment, le frai débutait lorsque la température de l'eau de surface atteignait de 2,5 à 3,5 °C. Les dangers que représentaient les glaces dans le port de Tuktoyaktuk juste avant la période de frai semblent indiquer que cette région ne convient pas à la culture d'oeufs. Les conditions semblent favorables dans la région des Doigts de la baie de Liverpool. Ce rapport présente les données biologiques (longeur, âge, poids, sexe, maturité et état) des échantillons de harengs pris au cours de cette étude.

Mots-clés: composition selon l'âge, rapport prise-effort; pêche expérimentale; filets maillants; maturité sexuelle; répartition par taille; saisons du frai.

INTRODUCTION

Pacific herring are distributed along the west coast of North America from California northward to the Beaufort Sea (Hart 1973). Rounsefell (1930) reported their occurrence along the Alaskan coast as did Kendel et al. (1975) along the Yukon coast and east of the Mackenzie Delta. Pacific herring have been reported in the nearshore waters of the Beaufort Sea (Riske 1960, Bray 1975, Galbraith and Hunter 1975) and in the numerous large inlets and bays of the Tuktoyaktuk Peninsula (Bond 1982; Lawrence et al. 1984) and Liverpool Bay (Riske 1960; Hunter and Leach 1981). They have been captured as far east as the Coppermine River (Gillman and Kristofferson 1984).

Herring fisheries are not new to the Beaufort Sea area. An experimental fishery operated near Baillie Island in 1963 (Corkum and McCart 1981) but it failed due to high production and transportation costs. Due to the success of the herring roe fishery on Canada's west coast interest in Beaufort Sea herring has been renewed. The high value of roe compared with the herring carcass offers the possibility that high transportation costs can now be overcome. A ready market for the roe exists in Japan. Considering the above, the Department of Fisheries and Oceans undertook to determine the feasibility of developing a herring roe fishery in this area.

The initial stage of the investigation was designed to determine where and when the herring spawned since the roe must be harvested just prior to spawning. Studies were conducted in Tuktoyaktuk Harbour in the spring of 1981 and 1982 and the Liverpool Bay area in the spring of 1981, 1982 and 1983 (Fig. 1).

Samples of herring were collected for baseline biological data and herring roe were processed for market evaluation. A summary of the biological data collected during this stage of the investigation is presented in graphic and tabular form in this report.

MATERIALS AND METHODS

GILLNET SURVEY

The investigation began in Tuktoyaktuk Harbour (Fig. 2) since herring were known to frequent this location and it was easily accessible. For a description of Tuktoyaktuk Harbour see Bond (1982), Barber (1968) and Mackay (1963).

Fishing began May 4 and ended June 15, 1981. Nylon gillnets of 64 mm mesh size (stretched measure) were used. The nets ranged from 2-4 m in depth and 10-50 m in length. At the outset fishing was done through the ice with the aid of an auger and ice jigger for setting the nets. Towards the end of the study period the ice began to break up and nets were set in cracks in the ice and finally, in open water. Two sets using identical gear to that used in 1981 were made on June 28, 1982, in open water to determine whether the herring had completed spawning. Net locations are shown in Fig. 2. Ice thickness and condition, water depth and surface water temperature were recorded at each location, as well as number of hours fished and number of fish captured by species. A summary of the data on fishing effort appears in Appendix 1. Additional information collected during the survey period are on file with the Fish and Marine Mammal Management Division of the Department of Fisheries and Oceans, Western Region, Winnipeg, Manitoba.

Catch per unit of effort (CPE) was calculated by dividing the number of herring caught by the length of the net and the number of hours fished. CPE was then expressed as the number of herring caught per 100 metres of net per 24 hours.

The survey began in the Liverpool Bay area in 1981 (Fig. 3). For a description of this area see Hunter and Leach (1981), and Hunter (1975). Two gillnets were set at the lower end of the first inlet west of Liverpool Bay on June 9, 1981 (Fig. 4). This effort was coincident with the gillnet survey in progress in Tuktoyaktuk Harbour in order to determine whether spawning times differed between the two locations. The gear used was identical to that used in the Tuktoyaktuk Harbour study.

The 1982 survey began through the ice on May 28 and ended June 25. As the study progressed nets were set in cracks and along open leads as opportunities arose. An additional six days of open water gillnetting was conducted in the southern portion of Liverpool Bay from July 2 to July 8. Gillnets used were commercial type monofilament herring nets with a shaker panel of larger mesh size in the midsection of each net. Mesh size of most gillnets was 64 mm although two were 57 mm. The latter were removed early in the study and no herring samples were taken from them. All gillnets were 4 m in depth and ranged from 10-100 m in length. Net locations are shown in Fig. 4.

The 1983 survey was confined to the first narrow inlet or "finger" dividing Liverpool Bay and the Eskimo Lakes (Fig. 4). Fishing took place from June 11 to June 19 (Fig. 5). The commercial type herring gillnets described for the 1982 study were used. Fishing initially took place through the ice with cracks and leads being utilized later. Additional gillnetting was done in open water from September 12 to September 15. Net locations are shown in Fig. 5.

Transportation of personnel and equipment during the three-year study was accomplished with snow machines, all terrain vehicles (Argo), fixed-wing aircraft, and helicopter in accordance with prevailing ice conditions. A summary of the gillnetting effort from 1981 to 1983 is given in Appendix 1. Individual net records were not kept during the June, 1983, survey as gillnetting was not conducted by Fisheries and Oceans personnel. However, estimates of the total catch of herring were made by recording the number of boxes of fish captured from each net and multiplying by an average total count of fish per box. A summary for the daily gillnetting effort and catch for June, 1983, appears in Appendix 2.

BIOLOGICAL INVESTIGATION

Herring were selected at random from gillnet catches and sampled for standard length (± 1 mm), round weight (± 10 g), sex and maturity. Maturity was determined by gross examination of the gonads. Sagittal otoliths and scales were removed from sampled herring for later age determination. Scales were removed from a position below the lateral line and behind the pectoral fin.

In the laboratory the ages were determined by lightly grinding the convex surface of the otoliths on a fine carborundum stone to expose the annual growth zones. Otoliths were then cleaned in a 3:1 solution of benzyl-benzoate and methyl salicylate, placed in a depression slide and the annuli were counted with the aid of a dissecting microscope (X30). Scales were placed between two glass slides and the annuli counted on the resulting image produced by an Eberbach microprojector (X60). Scale age in years was interpreted as being equal to the number of completed annuli.

Condition factor (K), a measure of the plumpness or robustness of the herring was calculated as:

$$K = \frac{W \times 10^5}{L^3}$$

Where W = weight in grams
L = standard length in millimeters

In order to monitor gonadal development and determine the onset of spawning, the gonosomatic index (GSI) was calculated. Ovaries were removed and weighed to the nearest gram. The GSI was then determined as follows:

$$GSI = \frac{\text{Gonad Weight}}{\text{Fish Round Weight}} \times 100$$

Incidental species captured were identified according to Scott and Crossman (1973) and Hart (1973). No samples were taken of incidental species.

Data collected were analyzed using an Amdahl 470/V7 computer based at the University of Manitoba with a terminal located at the Freshwater Institute. The Statistical Analysis System (1979) was used to generate length, weight, age, sex and maturity summaries and to perform basic calculations. Some additional calculations were performed using a Hewlett-Packard programmable calculator (Model 9810-A).

RESULTS

GILLNET SURVEY

A summary of the catch statistics for herring is presented in Table 1. A total of 1 685 herring were captured in Tuktoyaktuk Harbour in May and June, 1981. However, ice conditions deteriorated rapidly just prior to the onset of spawning making fishing very difficult and hazardous. The gillnets set in Liverpool Bay at this time captured 130 herring. Ice conditions there were better and the herring were still in prespawning condition. This led to the decision to abandon Tuktoyaktuk Harbour in favour of Liverpool Bay for future investigations.

The survey in the Liverpool Bay area in June, 1982, captured a total of 2 466 herring from all the locations, most in prespawning condition. The CPE varied with each location (Table 1) indicating a nonuniform distribution. Ice conditions were favourable and did not present any hazards to fishing. Herring appeared to be most abundant in the first inlet west of Liverpool Bay (Fig. 4), so this area was selected as the site for the 1983 investigation. The gillnets set in Tuktoyaktuk Harbour in June, 1982, captured 572 herring, most in spent condition. Thus, it appears that herring spawn at an earlier date in Tuktoyaktuk Harbour than in the Liverpool Bay area. The open water sets in the Liverpool Bay area in July, 1982, captured 468 herring in spent condition indicating spawning was completed by this time. The CPE was relatively uniform suggesting that spawning aggregations had dissipated.

Gillnetting in June, 1983, produced the largest catch. Over 37 000 herring were taken. Effort was deliberately high in order to obtain a target of 450 kg of roe for market evaluation. The range in CPE was large (Table 1) indicating nonuniform distribution. Areas of high CPE suggested the presence of spawning aggregations. Based on these areas, spawning sites were tentatively identified (Fig. 5). Ice conditions varied and breakup had begun when most herring were harvested. However, fishing was not unduly hazardous or difficult. The open water gillnetting in September, 1983, produced 563 herring. The CPE was relatively uniform during this period.

BIOLOGICAL INVESTIGATION

Observations made during the three-year survey indicate that spawning occurs in conjunction with the spring ice breakup in shallow inshore areas. The GSI is of particular importance in the timing of roe fisheries as a rapidly increasing mean GSI indicates the onset of spawning (Hay and Outram 1981). Roe in optimum condition occur just prior to spawning hence fishing must take place over a very short period of time. However, results of this study suggest mean GSI may not be a good indicator of the onset of spawning in this location.

Mean GSI is compared on a daily basis with surface water temperature in Table 2. In Tuktoyaktuk Harbour in 1981 the GSI rose from 13.3% on May 4 to 22.3% on June 8. Spawning activity, that is the presence of spent herring in the catch, was first noted on June 11 when the mean GSI was 21.2% and surface water temperature had reached 2.5°C. In the Liverpool Bay area in 1982 the mean GSI showed little change from June 5 when it was 17.0% to June 20 when it was 20.2%. Spawning activity was first observed on June 13 when the mean GSI was 18.5% and surface water temperature was 3.0°C. Again, in the

Liverpool Bay area in 1983 the GSI showed little change throughout the course of the survey. It was 15.1% on June 11 and rose slightly to 17.2% on June 15 where it remained relatively constant until June 19 when it was 17.1% and spawning activity was first observed. Surface water temperature was 3.5°C.

Mean GSI and surface water temperature are compared on a daily basis in Fig. 6. Temperature shows a steady increase throughout the study whereas the GSI fluctuates. The onset of spawning activity did not appear to be associated with a rapid consistent increase in GSI whereas it was observed to take place when surface water temperature was recorded at 2.5 to 3.5°C.

The length-frequency distribution of the sample of herring taken in Tuktoyaktuk Harbour in 1981 and 1982 is shown in Fig. 7. The age-frequency distributions are shown in Fig. 8. Modal length of the 1981 sample was 290-299 mm (N = 216). Modal length of the 1982 sample was 270-289 mm (N = 50). Modal age of the 1981 sample was 12 years (N = 110). Modal age of the 1982 sample was also 12 years (N = 49).

Biological data by length interval for 1981 and 1982 Tuktoyaktuk Harbour samples are shown in Tables 3 and 5 respectively. Mean length in 1981 was 296 mm (N = 216). Mean round weight was 306 g. In 1982 the mean length was 269 mm (N = 50) and mean round weight was 259 g. Biological data by age group for 1981 and 1982 are shown in Tables 4 and 6 respectively. Mean age in 1981 was 12.6 years (N = 110), and in 1982 was 11.2 years (N = 49).

Although samples were taken from the Liverpool Bay area in 1981, 1982, and 1983 transport difficulties during 1981 precluded a length and age summary from that year. The length-frequency distribution of the samples of herring taken in Liverpool Bay in 1982 and 1983 are shown in Fig. 7. The age-frequency distributions are shown in Fig. 8. Modal length of the 1982 sample was 260-269 mm (N = 293). Modal length of the 1983 sample was 260-269 mm (N = 111). Modal age of the 1982 sample was 11 years (N = 255), and modal age of the 1983 sample was 12 years (N = 111).

Biological data by length interval for 1982 and 1983 Liverpool Bay samples are shown in Tables 7 and 9 respectively. Mean length in 1982 was 265 mm (N = 293) and mean round weight was 233 g. Mean length of the 1983 sample was 265 mm (N = 111) and mean round weight was 233 g. Biological data by age group for 1982 and 1983 are shown in Tables 8 and 10, respectively. Mean age in 1982 was 11.0 years (N = 255) and in 1983 was 11.1 years (N = 111).

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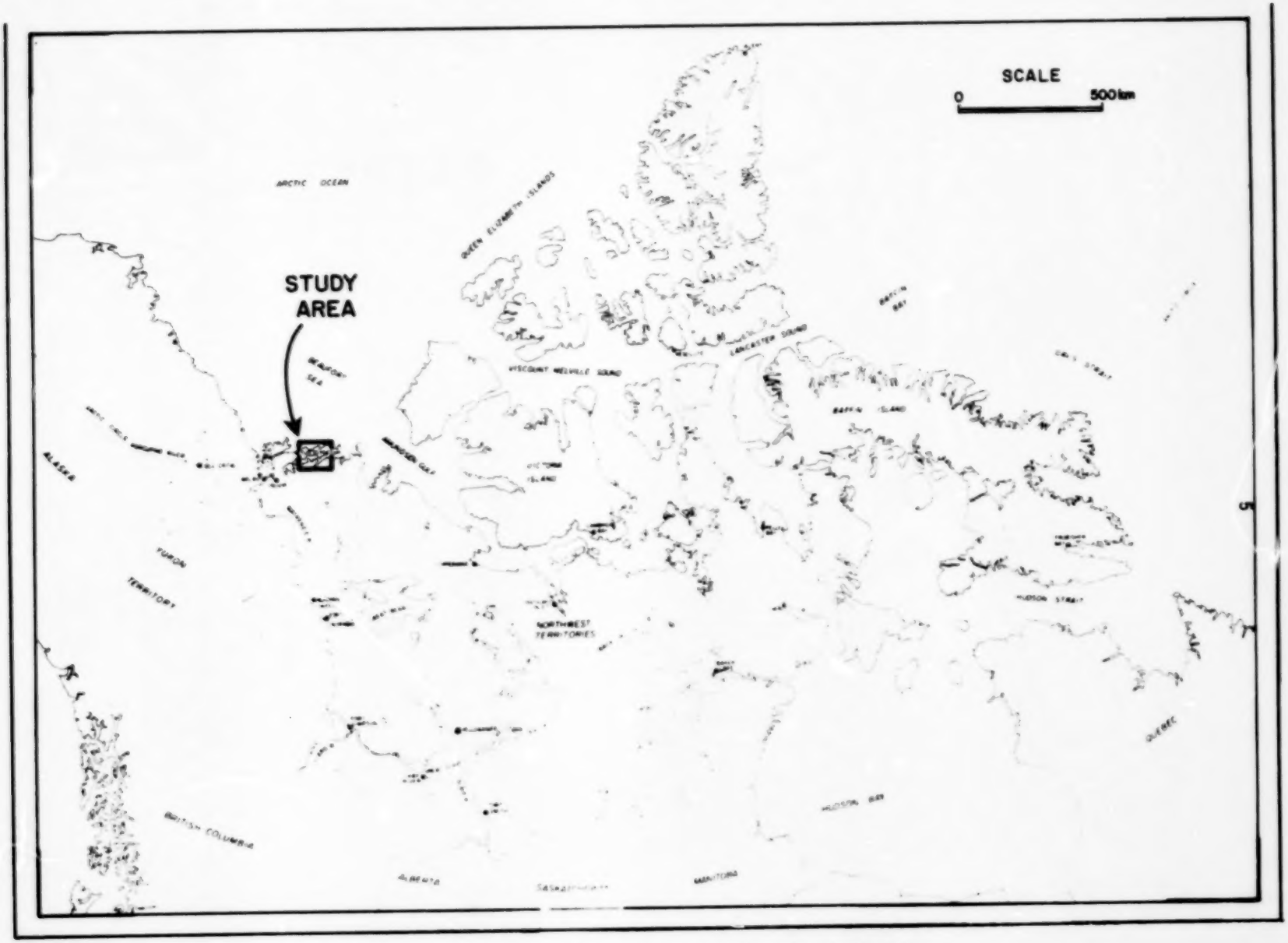

Fig. 1. Map of the Northwest Territories showing the study area.

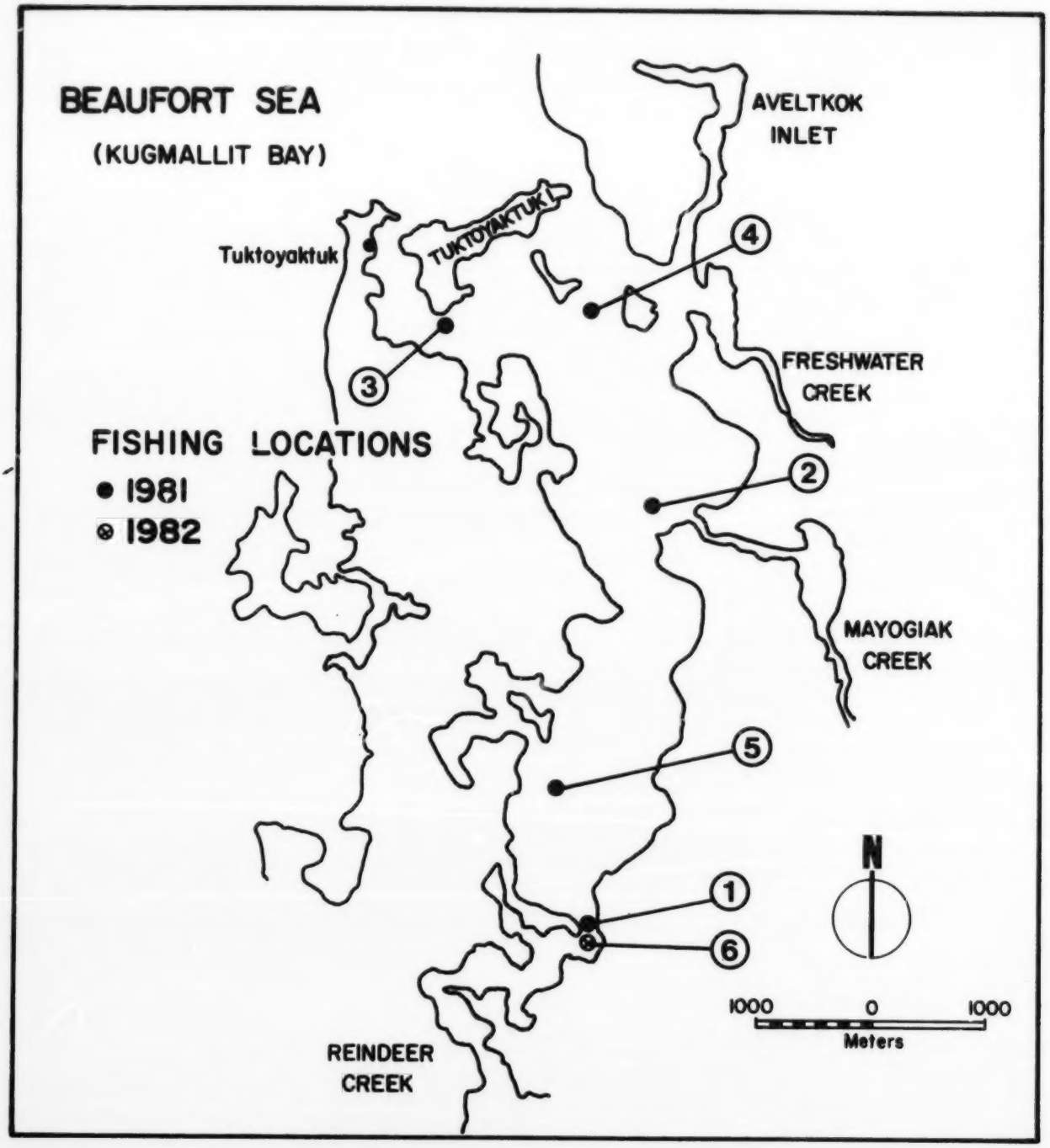

Fig. 2. Map of Tuktoyaktuk Harbour showing locations fished during 1981 and 1982 (from Bond 1982).

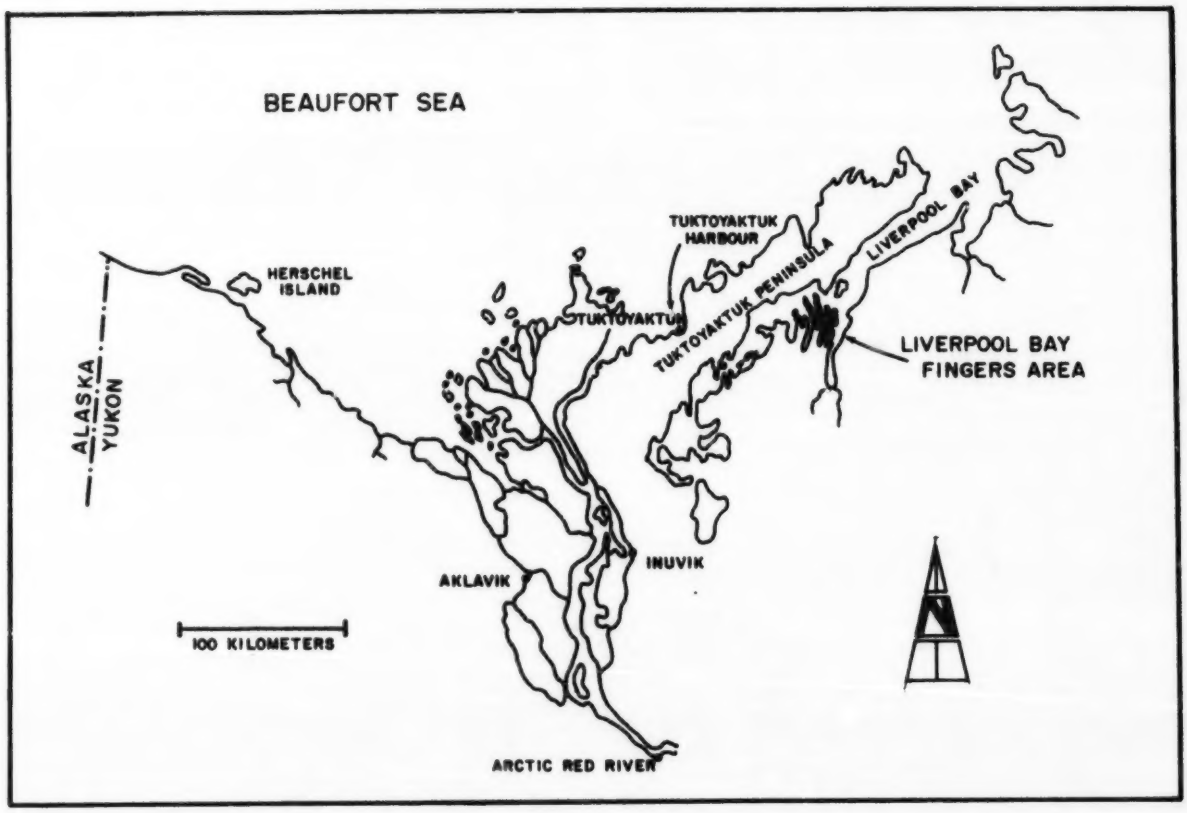

Fig. 3. Map of the Beaufort Sea and Liverpool Bay showing the relative locations of Tuktoyaktuk Harbour and the Fingers area (from Bond 1982).

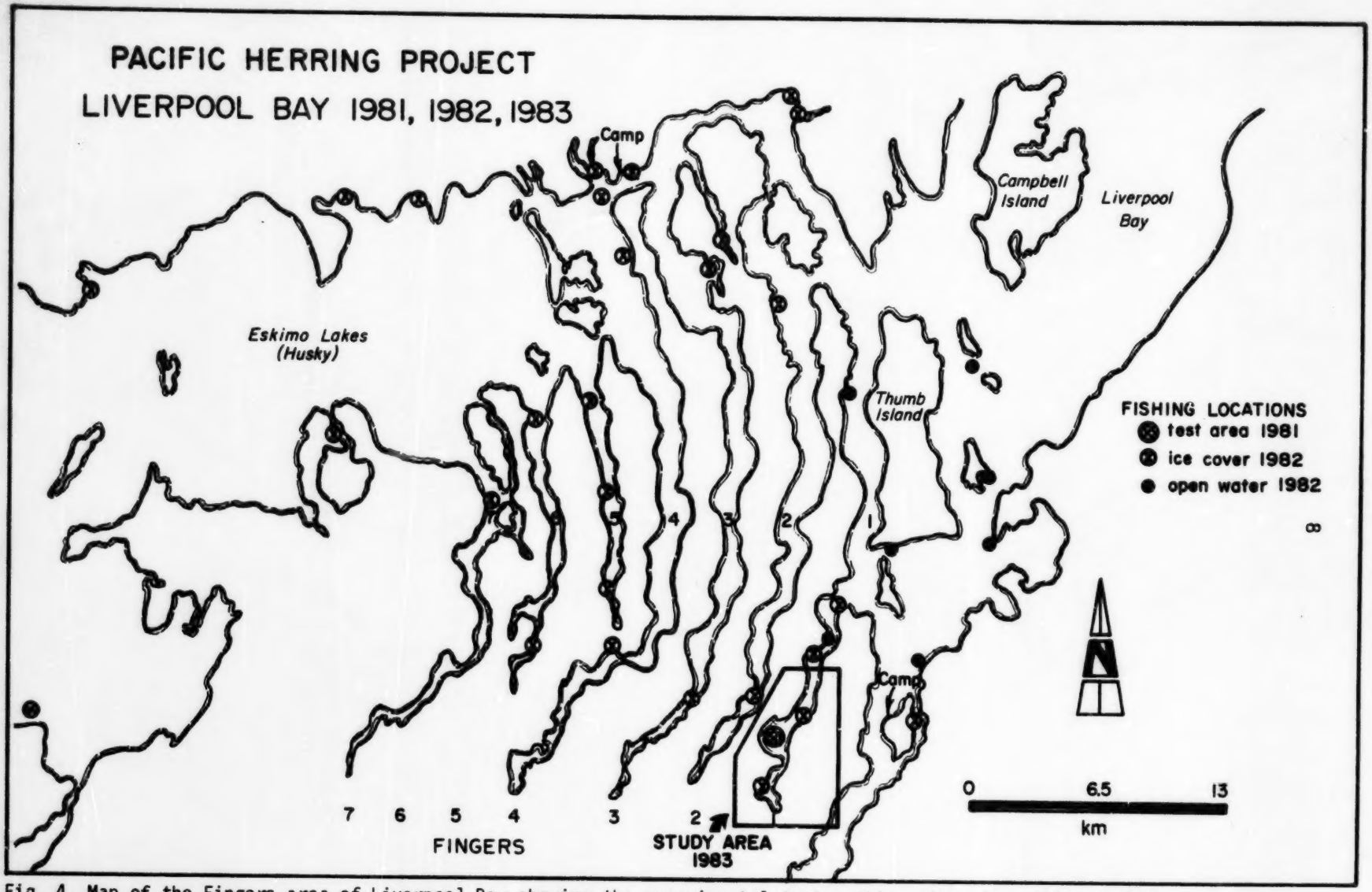

Fig. 4. Map of the Fingers area of Liverpool Bay showing the experimental test netting sites from 1981 to 1983.

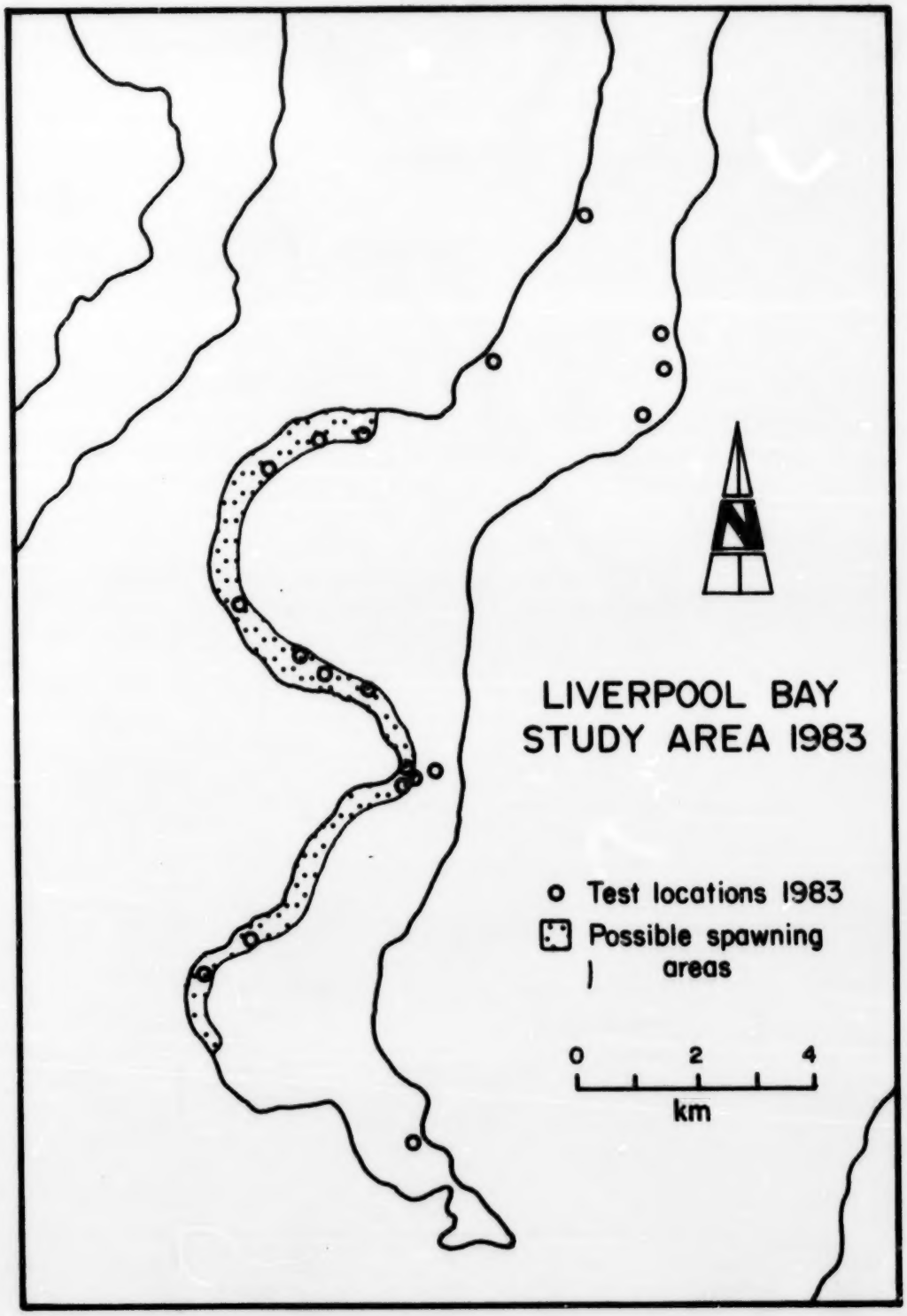

Fig. 5. Map of the southern portion of the first Finger showing the locations fished during 1983 and possible spawning grounds.

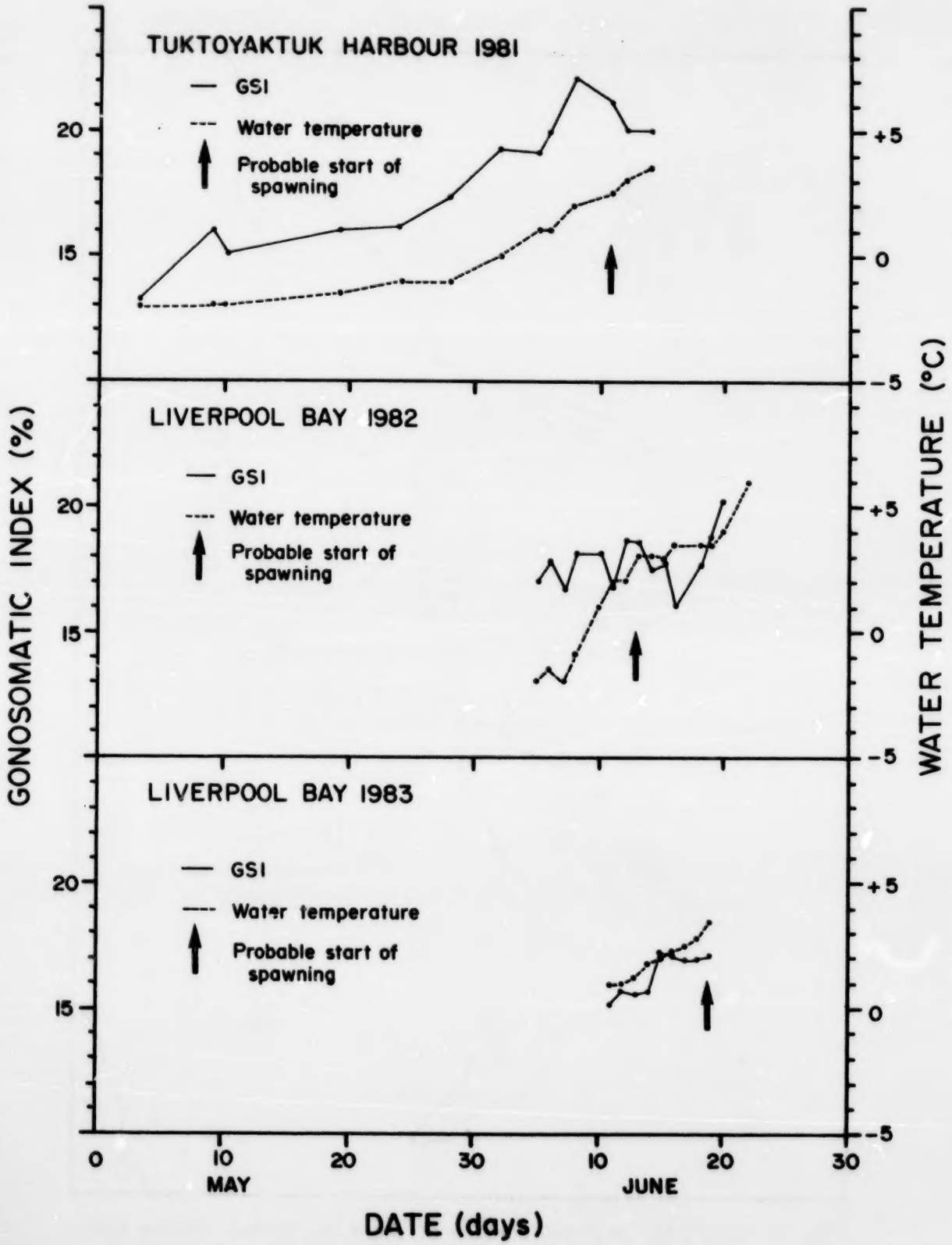

Fig. 6. Daily surface water temperature, gonosomatic index, and spawning activity for Pacific herring from Tuktoyaktuk Harbour and the Liverpool Bay area, 1981 to 1983.

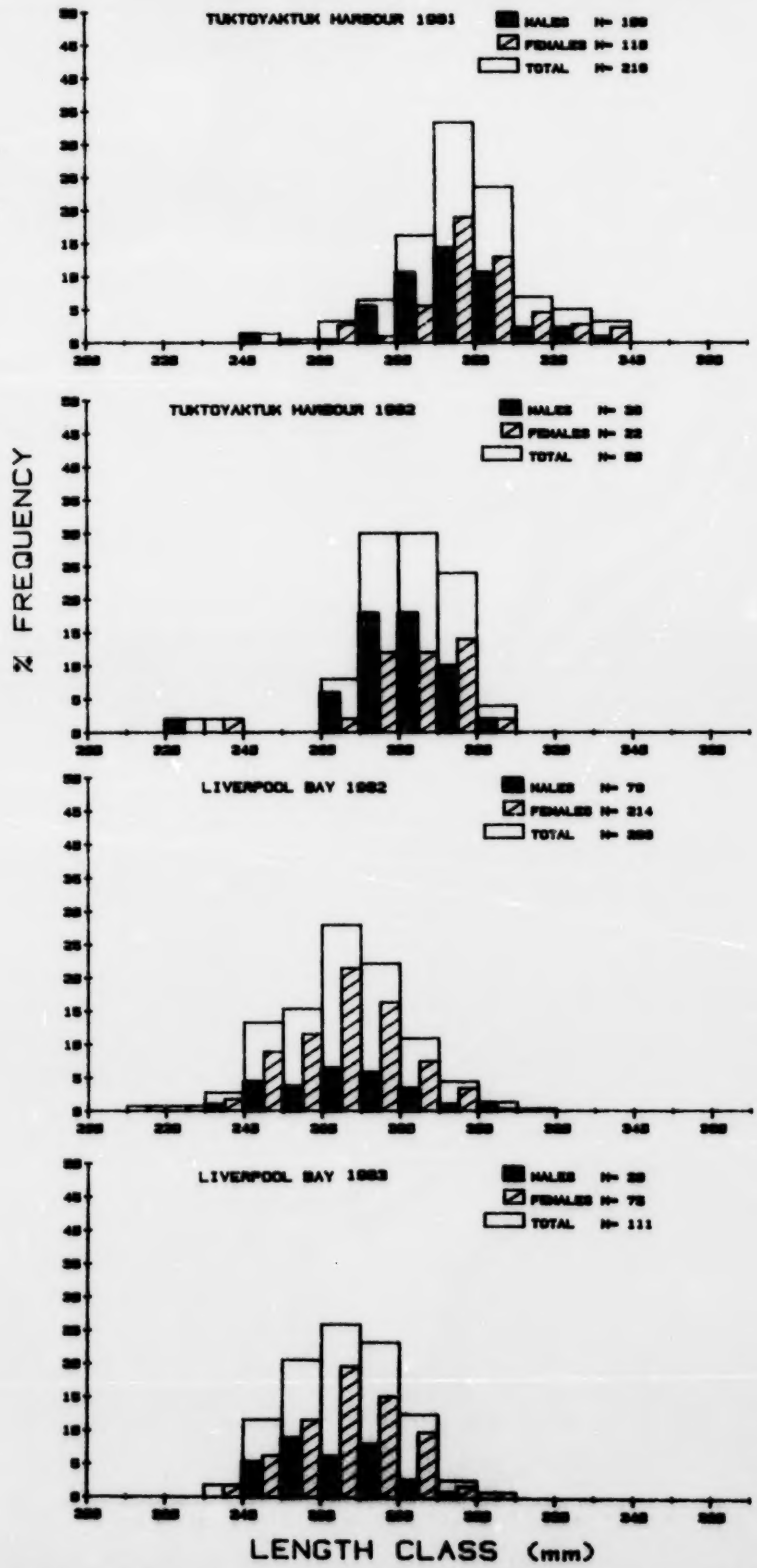

Fig. 7. Length-frequency distributions of Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour and the Liverpool Bay area, 1981 to 1983.

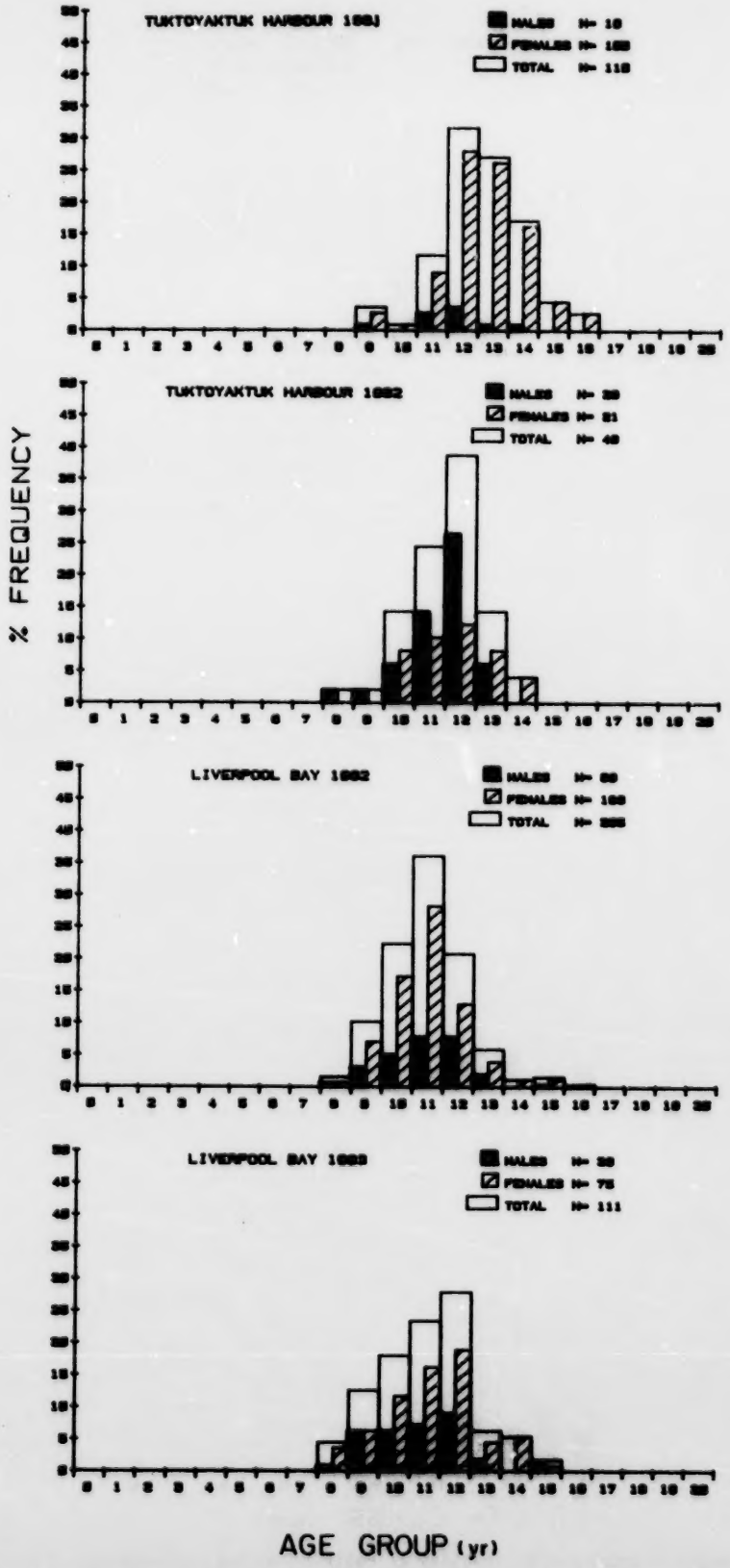

Fig. 8. Age-frequency distributions of Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour and the Liverpool Bay area, 1981 to 1983.

Table 1. Catch statistics for Pacific herring taken by gillnet in Tuktoyaktuk Harbour and the Liverpool Bay area, 1981-83.

Location	Year	Month	Total No. Nets Set	Total No. Herring Captured	Mean CPE*	Range in CPE
Tuktoyaktuk Harbour	1981	May, June	33	1 685	347	4 - 805
	1982	June	2	572	736	0 -1 452
Liverpool Bay area	1981	June	2	130	130	124 - 135
	1982	June	66	2 466	111	1 -1 385
		July	6	468	504	258 - 748
	1983	June	111	37 100†	1460	44 -5 800
		September	4	563	116	63 - 131

* No. of herring/100 m/24 h.
† Estimated by no. of boxes of fish captured.

Table 2. Daily surface water temperature and gonosomatic index of Pacific herring from Tuktoyaktuk Harbour and the Liverpool Bay area, 1981-83.

Location	Year	Date	Temperature °C	Gonosomatic Index(%) Mean	Gonosomatic Index(%) Range	Spawning Activity
Tuktoyaktuk Harbour	1981	May 4	-2.0	13.3		
		9	-2.0	16.1		
		10	-2.0	15.0		
		19	-1.5	16.0	12.9-20.6	
		24	-1.0	16.2	13.3-20.9	
		28	-1.0	17.4	12.8-21.5	
		June 2	-0.0	18.3	13.4-24.2	
		5	1.0	18.2	13.4-21.8	
		6	1.0	20.0	17.3-23.5	
		8	2.0	22.3	18.9-23.7	
		11	2.5	21.1	17.8-22.6	Yes
		12	3.0	20.0	19.4-20.6	Yes
		14	3.5	20.0		Yes
Liverpool Bay area	1982	June 5	-2.0	17.0	12.3-20.8	
		6	-1.5	17.8	11.0-20.9	
		7	-2.0	16.6	14.6-19.2	
		8	-1.0	18.0	12.2-21.5	
		10	1.0	18.1	11.8-24.4	
		11	2.0	16.6	13.8-19.8	
		12	2.5	18.6	13.0-21.7	
		13	3.0	18.5	13.5-25.3	Yes
		14	3.0	17.3	12.2-20.2	Yes
		15	3.0	17.7	15.4-21.5	
		16	3.5	15.8	11.0-19.2	
		18	3.5	17.6	12.8-20.2	Yes
		19	3.5	18.8	14.2-22.1	
		20	4.0	20.2	15.6-23.4	Yes
		22	6.0			
Liverpool Bay area	1983	June 11	1.0	15.1	11.0-21.2	
		12	1.0	15.7	11.0-20.1	
		13	1.25	15.6	11.3-22.9	
		14	1.75	15.7	11.8-22.6	
		15	2.0	17.2	11.0-22.9	
		16	2.25	17.1	14.0-21.6	
		17	2.5	16.9	13.6-21.4	
		18	2.75	16.9	14.7-21.4	
		19	3.5	17.1	15.1-18.9	Yes

Table 3. Biological data by length interval for Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour, 1981.

LENGTH INTERVAL (MM)	MALES						FEMALES						COMBINED					
	LENGTH(MM)		WEIGHT(G)			%	LENGTH(MM)		WEIGHT(G)			%	LENGTH(MM)		WEIGHT(G)			%
	N	MEAN	MEAN	SD	K	MAT	N	MEAN	MEAN	SD	K	MAT	N	MEAN	MEAN	SD	K	MAT
240	3	245	168	3	1.14	100	-	-	-	-	-	-	3	245	168	3	1.14	100
250	1	251	212	-	1.34	100	-	-	-	-	-	-	1	251	212	-	1.34	100
260	1	261	210	-	1.18	100	6	265	225	14	1.20	100	7	265	222	14	1.20	100
270	12	276	248	13	1.18	100	2	277	248	8	1.17	100	14	276	248	12	1.18	100
280	23	285	279	15	1.20	100	12	286	293	44	1.25	100	35	286	284	29	1.22	100
290	31	294	302	26	1.19	100	41	295	303	18	1.18	100	72	295	303	22	1.18	100
300	23	302	320	20	1.16	100	28	304	327	18	1.16	100	51	303	324	19	1.16	100
310	5	313	342	8	1.12	100	10	313	341	21	1.12	100	15	313	341	17	1.12	100
320	5	323	345	35	1.03	100	6	324	391	18	1.15	100	11	324	370	35	1.09	100
330	2	332	345	35	0.95	100	5	335	430	13	1.15	100	7	334	405	45	1.09	100
TOTAL	106						110						216					
MEAN		293	294	42	1.17			299	317	46	1.17			296	306	45	1.17	

Table 4. Biological data by age group for Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour, 1981.

AGE (YR)	MALES							FEMALES							COMBINED						
	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%
	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT
9	1	244	-	170	-	1.17	100	3	267	1.2	226	3	1.19	100	4	261	11.4	212	28	1.19	100
10	-	-	-	-	-	-	-	1	277	-	242	-	1.14	100	1	277	-	242	-	1.14	100
11	3	274	21.3	251	45	1.22	100	10	289	15.1	289	47	1.19	100	13	285	17.0	280	48	1.20	100
12	4	294	8.7	304	49	1.19	100	31	296	8.3	309	34	1.19	100	35	296	8.3	309	35	1.19	100
13	1	308	-	323	-	1.11	100	29	303	8.7	327	29	1.17	100	30	303	8.6	327	29	1.17	100
14	1	320	-	380	-	1.16	100	18	312	14.6	348	54	1.14	100	19	312	14.3	350	53	1.14	100
15	-	-	-	-	-	-	-	5	313	16.3	353	54	1.14	100	5	313	16.3	353	54	1.14	100
16	-	-	-	-	-	-	-	3	305	25.2	345	69	1.21	100	3	305	25.2	345	69	1.21	100
TOTAL	10							100							110						
MEAN		287	24	284	67	1.18			300	14.8	319	47	1.17			299	16.2	316	50	1.17	
MEAN AGE	12.6																				

Table 5. Biological data by length interval for Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour, 1982.

Length Interval (mm)	Males						Females						Combined					
	Length(mm)		Weight(g)			%	Length(mm)		Weight(g)			%	Length(mm)		Weight(g)			%
	N	Mean	Mean	SD	K	Mat.	N	Mean	Mean	SD	K	Mat.	N	Mean	Mean	SD	K	Mat.
220	1	225	150	-	-	100	-	-	-	-	-	-	1	225	150	-	1.13	100
230	-	-	-	-	-	-	1	235	170	-	-	100	1	235	170	-	1.14	100
260	3	266	206	15	1.17	100	1	265	210	-	-	100	4	266	207	8	1.17	100
270	9	274	247	13	1.18	100	6	274	252	24	1.16	100	15	274	249	17	1.18	100
280	9	281	267	18	1.15	100	6	282	275	19	1.15	100	15	281	270	17	1.16	100
290	5	293	290	7	1.15	100	7	292	281	24	1.17	100	12	292	281	31	1.15	100
300	1	304	260	-	-	100	1	303	370	-	-	100	2	304	315	55	-	100
Total	28						22						50					
Mean		261	254	24	1.15	100		281	260	68	1.16	100		269	259	61	1.16	100

Table 6. Biological data by age group for Pacific herring captured by experimental gillnets in Tuktoyaktuk Harbour, 1982.

Age (Yr)	Males							Females							Combined						
	Length(mm)			Weight(g)			%	Length(mm)			Weight(g)			%	Length(mm)			Weight(g)			%
	N	Mean	SD	Mean	SD	K	Mat.	N	Mean	SD	Mean	SD	K	Mat.	N	Mean	SD	Mean	SD	K	Mat.
8	1	225	-	150	-	-	100	-	-	-	-	-	-	-	1	225	-	150	-	-	100
9	1	284	-	280	-	-	100	-	-	-	-	-	-	-	1	284	-	280	-	-	100
10	3	279	3	270	10	1.14	100	4	262	20	234	50	1.19	100	7	269	11	248	24	1.16	100
11	7	277	13	237	18	1.10	100	5	281	7	258	19	1.16	100	12	279	10	245	21	1.13	100
12	13	282	6	276	17	1.18	100	6	281	7	272	30	1.18	100	19	281	6	275	21	1.18	100
13	3	295	4	295	5	1.19	100	4	296	5	325	15	1.19	100	7	296	5	303	31	1.19	100
14	-	-	-	-	-	-	100	2	292	2	305	5	1.21	100	2	292	2	305	5	1.21	100
Total	28							21							49		18				
Mean		261	21	254	35	1.15			281		260	68	1.18			269		259	61	1.17	
Mean Age	11.2																				

Table 7. Biological data by length interval for Pacific herring captured by experimental gillnets in the Liverpool Bay area, 1982.

LENGTH INTERVAL (MM)	MALES						FEMALES						COMBINED					
	LENGTH(MM)		WEIGHT(G)			%	LENGTH(MM)		WEIGHT(G)			%	LENGTH(MM)		WEIGHT(G)			%
	N	MEAN	MEAN	SD	K	MAT	N	MEAN	MEAN	SD	K	MAT	N	MEAN	MEAN	SD	K	MAT
210	-	-	-	-	-	-	2	215	131	1	1.32	100	2	215	131	1	1.32	100
220	-	-	-	-	-	-	2	224	132	0	1.18	100	2	224	132	0	1.18	100
230	3	235	159	15	1.22	100	5	234	171	33	1.33	100	8	235	166	27	1.29	100
240	13	245	174	10	1.18	100	26	244	184	25	1.26	100	39	245	180	21	1.23	100
250	11	254	203	29	1.24	100	34	255	207	20	1.25	100	45	255	206	22	1.25	100
260	19	263	221	16	1.21	100	63	264	233	21	1.26	100	82	264	230	21	1.25	100
270	17	273	249	23	1.23	100	48	274	253	36	1.23	100	65	274	252	33	1.23	100
280	10	283	274	27	1.21	100	22	285	290	34	1.26	100	32	284	285	33	1.24	100
290	3	293	298	33	1.18	100	10	292	330	23	1.32	100	13	292	323	28	1.29	100
300	3	301	314	80	1.15	67	1	302	276	-	1.00	100	4	302	305	68	1.11	75
310	-	-	-	-	-	-	1	310	410	-	1.38	100	1	310	410	-	1.38	100
TOTAL	79						214						293					
MEAN		265	228	47	1.21			265	235	49	1.26			265	233	49	1.24	

Table 8. Biological data by age group for Pacific herring captured by experimental gillnets in the Liverpool Bay area, 1982.

AGE (YR)	MALES							FEMALES							COMBINED						
	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%	LENGTH(MM)			WEIGHT(G)			%
	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT
8	2	249	4.9	188	21	1.22	100	2	249	6.4	174	37	1.13	100	4	249	4.7	181	26	1.17	100
9	8	249	10.3	186	29	1.20	100	18	250	12.2	196	31	1.25	100	26	250	11.5	193	30	1.24	100
10	13	254	9.2	193	28	1.18	100	44	260	17.2	217	48	1.22	100	57	259	15.9	211	45	1.21	100
11	20	262	13.6	222	38	1.23	100	72	265	12.9	237	40	1.27	100	92	264	13.0	233	40	1.26	100
12	20	276	12.4	254	37	1.21	100	33	274	11.6	265	43	1.28	100	53	275	11.8	261	41	1.25	100
13	5	287	12.9	309	48	1.30	100	10	273	12.9	266	53	1.30	100	15	278	14.2	280	54	1.30	100
14	-	-	-	-	-	-	-	3	291	14.0	303	50	1.24	100	3	291	14.0	303	50	1.24	100
15	1	282	-	282	-	1.26	100	3	282	11.2	307	37	1.37	100	4	282	9.2	301	33	1.35	100
16	-	-	-	-	-	-	-	1	310	-	410	-	1.38	100	1	310	-	410	-	1.38	100
TOTAL	69							186							255						
MEAN		265	16	228	49	1.21			265	16.0	237	50	1.26			265	16.1	234	50	1.25	
MEAN AGE	11.0																				

Table 9. Biological data by length interval for Pacific herring captured by experimental gillnets in the Liverpool Bay area, 1983.

LENGTH INTERVAL (MM)	MALES						FEMALES						COMBINED					
	N	LENGTH(MM) MEAN	WEIGHT(G) MEAN	SD	K	% MAT	N	LENGTH(MM) MEAN	WEIGHT(G) MEAN	SD	K	% MAT	N	LENGTH(MM) MEAN	WEIGHT(G) MEAN	SD	K	% MAT
230	-	-	-	-	-	-	2	232	156	11	1.25	100	2	232	156	11	1.25	100
240	6	246	179	30	1.20	100	7	245	175	22	1.19	100	13	245	176	25	1.20	100
250	10	255	205	36	1.23	100	13	254	205	20	1.25	100	23	255	205	28	1.24	100
260	7	262	227	17	1.26	100	22	264	237	28	1.29	100	29	263	235	26	1.28	100
270	9	272	248	25	1.24	100	17	274	253	29	1.22	100	26	273	251	27	1.23	100
280	3	281	269	23	1.21	100	11	284	282	35	1.23	100	14	284	279	33	1.22	100
290	1	296	314	-	1.21	100	2	293	346	48	1.39	100	3	294	335	39	1.33	100
300	-	-	-	-	-	-	1	305	316	-	1.11	100	1	305	316	-	1.11	100
TOTAL	36						75						111					
MEAN		262	224	41	1.23			266	238	47	1.25			265	233	45	1.24	

Table 10. Biological data by age group for Pacific herring captured by experimental gillnets in the Liverpool Bay area, 1983.

AGE (YR)	MALES							FEMALES							COMBINED						
	N	LENGTH(MM) MEAN	SD	WEIGHT(G) MEAN	SD	K	% MAT	N	LENGTH(MM) MEAN	SD	WEIGHT(G) MEAN	SD	K	% MAT	N	LENGTH(MM) MEAN	SD	WEIGHT(G) MEAN	SD	K	% MAT
8	1	245	-	170	-	1.16	100	4	239	8.5	154	8	1.13	100	5	240	7.8	157	10	1.14	100
9	7	250	4.8	173	18	1.10	100	7	250	6.7	196	24	1.26	100	14	250	5.6	185	24	1.18	100
10	7	256	5.5	210	37	1.25	100	13	257	8.7	206	21	1.22	100	20	257	7.6	208	27	1.23	100
11	8	263	5.7	234	20	1.29	100	18	265	8.4	233	25	1.25	100	26	264	7.6	233	23	1.26	100
12	10	270	10.3	255	25	1.30	100	21	272	6.7	262	39	1.31	100	31	271	7.9	260	35	1.31	100
13	2	279	7.8	240	6	1.11	100	5	283	5.2	264	26	1.16	100	7	282	5.8	257	25	1.15	100
14	-	-	-	-	-	-	-	6	286	6.4	301	43	1.28	100	6	286	6.4	301	43	1.28	100
15	1	296	-	314	-	1.21	100	1	305	-	316	-	1.11	100	2	301	6.4	315	1	1.16	100
TOTAL	36							75							111						
MEAN		262	12	224	41	1.23			266	14.5	238	47	1.25			265	13.9	233	45	1.24	
MEAN AGE	11.1																				

Appendix 1. Summary of information on sample dates, sample locations, set duration, depths, and catch by species for experimental gillnets set in Tuktoyaktuk Harbour and the Liverpool Bay area, 1981-83.

Area	Year	Date	Set Number	Location Number	Set Duration (h)	Net Length (m)	Mesh Size (mm)	Water Depth (m)	Catch by species									
									Pacific herring	Arctic cisco	Fourhorn sculpin	Saffron cod	Broad whitefish	Lake whitefish	Least cisco	Arctic cod	Starry flounder	Lake trout	Inconnu
Tuktoyaktuk Harbour	1981	May	9	1	2	14	50	64	5	2	13	1			2					2
			10	2	2	25	50	64	5	8	17	1		1	3					3
			10	3	3	13	50	64	6	67	14	2		1						
			11	4	2	24	50	64	5	12	13				1					4
			11	5	3	24	50	64	6	38	14	8			1	1				3
			19	6	2	27	50	64	5	10	16	2			1	1				2
			19	7	3	28	50	64	6	33	12	12			2	1				1
			24	8	3	22	50	64	6	4	33	1			4	4				2
			24	9	2	21	50	64	5	47	23	2	1							2
			28	10	3	15	50	64	6	22	3	2			4	2				1
			28	11	2	16	50	64	5	2	20				5	1				2
		June	2	12	4	15	50	64	6	2	16	1		10	3	7				
			2	13	2	15	50	64	5	26	61	2		2	2					3
			5	14	1	12	10	64	4	52	5	4			3					
			6	15	1	17	10	64	4	47	9	1		5	2	1				2
			6	16	2	16	50	64	5	20	76	1		1	5	11				1
			6	17	4	13	50	64	6	3	4			5	1	1				
			7	18	4	24	50	64	6	2	7			16	6	7				
			7	19	2	23	50	64	5	51	87	2		1	15	9				
			7	20	1	24	10	64	4	62	10				5	1				3
			8	21	2	22	50	64	5	43	81		1	3	8	11				5
			8	22	1	23	10	64	4	56	15	2		4	5	2				
			9	23	5	15	50	64	8	60	120			7	4	11				1
			9	24	1	15	10	64	4	50	3			4	8	1				1
			10	25	2	20	50	64	5	35	60	2		4	8	9				2
			10	26	1	22	10	64	4	34	16	2		6	5	4				
			11	27	2	23	50	64	5	28	55	3		6	13	10				1
			11	28	1	22	10	64	4	50	15	2		2	3	11				
			12	29	5	24	50	64	8	38	42	1		5	6	10				
			12	30	1	24	50	64	4	103	27	4		5	4	6				1
			13	31	5	23	50	64	8	30	57	1		5	5					1
			14	32	1	22	50	64	4	369	19	10	1	1	18	4				1
			15	33	1	19	50	64	4	279	19	3	1	2	15	6				
Liverpool Bay	1981	June	9	1	4	24	50	64	5	62	80	12		7	3	73		18		
			9	2	4	24	50	64	2	68	2	16	67				4			
Tuktoyaktuk Harbour	1982	June	28	1	1	8	35	64	4		11	3	2	6	13	3				1
			29	2	1	27	35	64	4	572	71	4	1	31	50					2

Appendix 1. Cont'd.

Area	Year	Date	Set Number	Location Number	Set Duration (h)	Net Length (m)	Mesh Size (mm)	Water Depth (m)	Catch by species									
									Pacific herring	Arctic cisco	Fourhorn sculpin	Saffron cod	Broad whitefish	Lake whitefish	Least cisco	Arctic cod	Starry flounder	Lake trout	Inconnu
Liverpool Bay	1982	June	2	1	13	16	50	64	5										
			4	2	13	23	50	64	15			3				1			
			5	3	13	24	50	64	15			2							
			5	4	2	27	75	64	20	1		9							
			5	5	14	24	100	64	20	9		8	8			10			
			5	6	15	68	100	64	15	3			1			2			
			5	7	12	68	50	64	8	13		1	1			3			
			6	8	14	15	100	64	15	9		4	19			2			
			6	9	15	27	100	64	15			1				2			
			6	10	12	26	50	64	12	22						4			
			6	11	11	27	75	64	20										
			7	12	10	23	100	64	12										
			7	13	13	15	50	64	10			3	1						
			7	14	14	22	50	64	15	5		2				1			
			7	15	15	21	50	64	15			2				1			
			7	16	12	22	50	64	12	5		2				2			
			7	17	4	24	75	64	30	6	2		3						
			8	18	4	16	75	64	30	68		4	103			1			
			9	19	5	18	40	57	8	279	2		2						
			9	20	4	23	50	64	4	93	33	2	58			4			
			9	21	4	21	50	64	5	46									
			9	22	12	48	50	64	12	3		1				1			
			9	23	14	58	50	64	15	43		3	12			7			
			10	24	5	24	25	64	8	80			11			2			
			11	25	5	24	25	64	8	80		2	5			2			
			11	26	16	26	50	64	15	1		1							
			11	27	17	25	50	64	10							3			
			11	28	18	48	50	64	10				4			2			
			11	29	13	48	50	64	10	1		6	3						
			13	30	18	48	50	64	10			2				7			
			12	31	7	24	50	64	12			1				2			
			12	32	5	24	25	64	8	80		6	2			1			
			13	33	5	24	25	64	8	74	3	1	1						
			13	34	16	22	40	57	15	46	5		2	2	2				
			14	35	13	23	50	64	10			3	8						
			14	36	5	25	25	64	8	139	5			1					
			15	37	10	24	50	64	12										
			15	38	16	20	50	64	15	4									
			15	39	17	22	50	64	10	2									
			15	40	7	23	50	64	12			1							
			15	41	18	48	50	64	10			1							
			15	42	19	48	50	64	10	5									
			15	43	5	24	25	64	8	187	8	4	7						
			15	44	3	24	50	64	5	5	2			3					

Appendix 1. Cont'd.

Area	Year	Date	Set Number	Location Number	Set Duration (h)	Net Length (m)	Mesh Size (mm)	Water Depth (m)	Catch by species: Pacific herring	Arctic cisco	Fourhorn sculpin	Saffron cod	Broad whitefish	Lake whitefish	Least cisco	Arctic cod	Starry flounder	Lake trout	Inconnu
Liverpool Bay	1982	June 16	45	14	48	50	64	15	104										
		16	46	13	48	50	64	10	1		6	1							
		16	47	12	56	50	64	12	20			4					1		
		17	48	14	28	50	64	15	67			5							
		18	49	22	36	50	64	10	1		75			12			8	4	
		18	50	21	38	50	64	10	1	2	25			14				11	
		18	51	20	41	50	64	10	12			3							
		18	52	14	48	50	64	15	62										
		16	53	5	24	25	64	6	316	6	8	4							
		17	54	5	25	25	64	6	243	8	13	8							
		18	55	5	24	25	64	5	197		30	7							
		20	56	20	46	50	64	8	1			3							
		21	57	14	42	50	64	15	5			2							
		22	58	14	24	50	64	4	72										
		22	59	26	24	50	64	4			8	1							
		22	60	25	48	50	64	6			30	6					1		
		22	61	24	48	50	57	10			5	1							
		22	62	23	47	50	64	12	4		20	4					4		
		22	63	20	48	35	64	8	51			2							
		24	64	27	43	35	64	9											
		25	65	22	48	50	64	2			15			2				5	
		27	66	13	30	50	64	5			10	12				1			
		July 2	67	3	14	25	64	3	96	61				28	12				
		2	68	4	14	25	64	4	82	25		2		24					
		3	69	6	24	25	64	5	98			3							
		4	70	7	24	25	64	5	60	4		1		2					
		5	71	8	24	25	64	4	112	1	6			6					
		6	72	9	24	25	64	6	20	3	4			11					
Liverpool Bay	1983	Sept 12	1	3		25	64	3	168	19	1	1	3	6	9		3		
		13	2	4		35	64	2	110	13	2	3							
		14	3	5		25	64	3	109	6			1	1	4		1		
		15	4	4		35	64	8	186	28	1						1		

Appendix 2. Summary of information on daily fishing effort and catch of Pacific herring from gillnets set in the Liverpool Bay area, June 1983.

Location	Date	No. of Nets	Total Length of Nets (m)	Set Duration (h)	No. of Boxes	No. of* Captured Herring	CPE†
Finger No. 1	June 11	3	150	45	-	620	220
	12	3	125	54	-	217	77
	13	14	420	203	5	1 160	33
	14	14	420	196	7	1 480	43
	15	14	420	210	18	3 960	108
	16	18	540	180	24	5 280	130
	17	23	1 270	280	35	7 700	53
	18	13	900	159	12	2 680	44
	19	9	450	122	64	14 000	612
Total		111	4 695	1 449	165	37 097	

* Estimated on average of 220 herring per fish box.
† No. of herring/100 m/24 h.